DISPENSING AND DIVERSION SYSTEMS AND METHODS

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[0001] This application claims priority from U.S. Patent Application No. 10/601,670, entitled "Dispensing And Diversion Systems And Methods," and filed on June 24, 2003, which claims priority from U.S. Provisional Patent Application No. 60/390,371 entitled "Dispensing and Diversion Systems and Methods," and filed on June 24, 2002, and U.S. Provisional Patent Application No. 60/454,596 entitled "Dispensing and Diversion Systems and Methods," and filed on March 17, 2003, the disclosures of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates generally to dispensing systems and methods. In particular, the present invention relates to dispensing systems and methods in which a plurality of items may be dispensed, such that dispensed items may be directed to containers or diverted away from containers depending upon a measured physical characteristic of each of the dispensed items.

2. Description of Related Art

[0003] In known dispensing systems and methods, a dispenser may receive and dispense a plurality of items. For example, a known dispenser may receive a plurality of items on an item-receiving surface, direct the items from the item-receiving surface to dispensing paths positioned around the item-receiving surface, and dispense the items from the dispensing paths. Moreover, known dispensing systems may count each dispensed item, so that predetermined quantities of items may be directed to containers, e.g., packages, boxes, bottles, jars, cans, bowls, plates, pans, and the like.

[0004] However, known dispensing systems may dispense items that are out-of-specification, i.e., items that have a measured physical characteristic that is greater than or less than a predetermined range of physical characteristics for that item. If within a plurality of items to be dispensed, some items have a physical characteristic that is greater than or less than a predetermined range of physical characteristics for that item, a problem may arise in maintaining a quality of items dispensed to each container. For example, known dispensing systems may

receive and dispense out-of-specification items, i.e., items having a volume, density, or weight that is greater than or less than a predetermined range of volumes, densities, or weights for that particular item. If within a plurality of items to be dispensed, some of the items are "out-of-specification", known dispensers may dispense the out-of-specification items to containers. Thus, containers may have one or more items, the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics for that item.

SUMMARY OF THE INVENTION

[0005] A need has arisen for dispensing systems and methods that dispense items in predetermined quantities to containers. More particularly, a need has arisen for dispensing systems that accurately measure a physical characteristic of each dispensed item and direct predetermined quantities of dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics, to a container. A further need has arisen for dispensing systems and methods that divert items, the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics, away from a container.

[0006] Dispensing systems of the present invention may dispense predetermined quantities of a variety of food items, e.g., dried food items, frozen food items, thawed food items, or the like. For example, such dispensing systems may dispense dried food items, such as dried pasta, dehydrated vegetables, or the like. Moreover, such dispensing systems may dispense frozen food items, e.g., frozen meat, frozen vegetables, or the like. The dispensing system of the present invention may dispense items of varying physical characteristic, e.g., varying weight, volume, density, temperature, or the like, including non-food items. For example, the dispensing system of the present invention may dispense fasteners, hardware, medical items, electronic parts, mechanical parts, metallic and non-metallic items, or the like.

[0007] In an embodiment of the present invention, a dispensing system comprises a dispenser comprising one or more dispensing paths for dispensing items. The system also comprises one or more dispensing heads. Each of the one or more dispensing heads receives items from at least one of the one or more dispensing paths. Moreover, each of the one or more dispensing heads comprises a dispensing chute for directing a first plurality of the received items toward the dispenser, in which at least one physical characteristic of each of the first plurality of

the received items is within a predetermined range of physical characteristics. Each of the one or more dispensing heads also comprises a diversion chute for directing a second plurality of the received items away from the dispenser. For example, the at least one physical characteristic of at least one of the second plurality of the received items may be greater than or less than the predetermined range of physical characteristics.

[0008] In an embodiment of the invention, a system for dispensing items comprises a dispenser, a sensing unit, a plurality of container chutes, and a plurality of diversion chutes. The dispenser comprises a plurality of dispensing paths for dispensing the items. The sensing unit measures a physical characteristic of each of the dispensed items. The plurality of container chutes directs each of the dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics, to containers. The plurality of diversion chutes diverts each of the dispensed items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, away from the containers.

[0009] In another embodiment of the invention, a dispensing system comprises a rotary, vibratory dispenser for receiving and dispensing items, at least one sensing unit, a plurality of container chutes, and a plurality of diversion chutes. The rotary, vibratory dispenser comprises a rotation drive for rotating the dispenser, a plurality of dispensing paths, and at least one vibration device for vibrating the plurality of dispensing paths, so that the plurality of dispensing paths dispenses the items singularly. The at least one sensing unit measures a physical characteristic of each of the singularly-dispensed items. The plurality of container chutes direct each of the singularly-dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics, to containers. The plurality of diversion chutes diverts each of the singularly-dispensed items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, away from the containers.

[0010] In a further embodiment of the invention, a dispensing method comprises the steps of dispensing items from a dispenser. A physical characteristic of each of the dispensed items is measured. Each of the dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics, is directed to a container chute. Each of

the items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, to a diversion chute.

[0011] In yet another embodiment of the invention, a dispensing method comprises the steps of dispensing items singularly from a rotary, vibratory dispenser. A physical characteristic of each of the singularly-dispensed items is measured. Each of the singularly-dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics is directed to a container. Each of the dispensed items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, is diverted away from the container. The diverted items are conveyed to a rejection bin.

[0012] A system for dispensing items comprises a dispenser, a sensing unit, and a plurality of container chutes, and a plurality of buckets. The dispenser comprises a plurality of dispensing paths for dispensing items. The sensing unit measures a physical characteristic of each of the dispensed items. The plurality of container chutes directs each of the dispensed items, the measured physical characteristic of which is within a predetermined range of physical characteristics, to containers. The plurality of buckets receives each of the dispensed items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics.

[0013] A method of dispensing items comprises the steps of dispensing items from a dispenser, measuring a physical characteristic of each of the dispensed items, directing each of the dispensed items the measured physical characteristic of which is within a predetermined range of physical characteristics to a container chute, and diverting each of the dispensed items the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics to a bucket.

[0014] In still yet another embodiment of the present invention, a dispensing system comprises a dispenser for receiving and dispensing items. The dispenser comprises a plurality of dispensing paths, at least one rotation drive for rotating the plurality of dispensing paths, and at least one vibration device for vibrating the plurality of dispensing paths, such that the plurality of dispensing paths dispenses the items singularly. the dispensing system also comprises at least one sensing unit for measuring a physical characteristic of each of the singularly-dispensed items, and a plurality of container chutes for directing each of the singularly-dispensed items, the

measured physical characteristic of which is within a predetermined range of physical characteristics, to containers. Moreover, the dispensing system comprises a plurality of diversion chutes for diverting each of the singularly-dispensed items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, away from the containers.

[0015] Other objects, features, and advantages of embodiments of the present invention will be apparent to persons of ordinary skill in the art from the following description of preferred embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The invention may be understood more readily by reference to the following drawings.

[0017] **Fig. 1** shows a cross-sectional view of a dispensing and diversion system according to an embodiment of the present invention.

[0018] **Fig. 2** shows a cross-sectional view of a rotary, vibratory dispenser of the dispensing and diversion system of the present invention.

[0019] **Fig. 3** is a cutaway, plan view of a rotary, vibratory dispenser of the dispensing and diversion system according to an embodiment of the invention.

[0020] **Fig. 4** is a cutaway, plan view of a rotary, vibratory dispenser of the dispensing and diversion system according to an alternate embodiment of the invention.

[0021] **Fig. 5** shows a cross-sectional view of a dispensing head according to an embodiment of the present invention.

[0022] **Fig. 6** shows a cutaway, plan view of a star wheel for use with the dispensing and diversion system of the present invention.

[0023] **Figs. 7a-7h** show an operation of a dispensing head according to another embodiment of the present invention.

[0024] **Fig. 8** shows a cross-sectional view of a dispenser according to another embodiment of the present invention.

[0025] **Fig. 9** shows a cross-sectional view of a feeder bowl according to an embodiment of the present invention.

[0026] **Figs. 10a-10b** show an operation of a dispensing head according to another embodiment of the present invention

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] **Figs. 1** and **2** show a dispensing system according to an embodiment of the present invention. The dispensing system 100 may include a dispenser for receiving and dispensing a plurality of items, sensing units for measuring a physical characteristic of each of the dispensed items, dispensing heads for receiving each of the dispensed items, for directing predetermined quantities of items, the measured physical characteristic of which is within a predetermined range of physical characteristics, to containers, and for diverting items, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics away from a container, a star wheel for positioning containers to receive the predetermined quantities of items, container chutes for directing the dispensed items to containers, and diversion chutes for diverting items away from containers.

[0028] As shown in **Figs. 1** and **2**, dispenser may include a rotary, vibratory dispenser. Rotary, vibratory dispenser, may include a feeder bowl 101 and a plurality of dispensing paths 102 positioned around feeder bowl 101. The shape and configuration of feeder bowl 101 may vary, depending upon a physical characteristic, e.g., a weight, a volume, a density, a temperature, a friction coefficient of a surface, or the like, of items to be dispensed. Feeder bowl 101 may be dome-shaped, hemispherical-shaped, conical-shaped, substantially-planar, or the like. Moreover, feeder bowl 101 may include a substantially planar peripheral edge 101a. **Figs. 1** and **2** show an embodiment of feeder bowl 101 with an attenuated conical shape and a substantially planar peripheral edge 101a. Feeder bowl 101 may include a substantially smooth item-receiving surface or a textured item-receiving surface, depending upon a physical characteristic, e.g., a weight, a volume, a density, a temperature, a friction coefficient of a surface of an item, or the like, of items to be dispensed.

[0029] **Fig. 9** shows another embodiment of feeder bowl 101. In this embodiment, feeder bowl 101 may comprise a plurality of sloped portions, and each of the sloped portions may be separated by a substantially cylindrical portion. For example, feeder bowl 101 may comprise a first sloped portion 902 and a second sloped portion 904 connected to first sloped portion 902 via a substantially cylindrical portion 906. Cylindrical portion 906 may form a vertical drop

between first sloped portion 902 and second sloped portion 904. In an embodiment, a thickness of cylindrical portion 906 may be selected, such that a distance between first sloped portion 902 and second sloped portion 904 is about 25.4 mm (about 1 inch). Moreover, first sloped portion 902, second sloped portion 904, and substantially cylindrical portion 906 may be stationary portions, i.e., non-rotating portions, or vibratory portions, or both. First sloped portion 902 and second sloped portion 904 may gradually accelerate the fall of items dispensed by bulk delivery apparatus 106 to feeder bowl 101. Specifically, a slope S1 of second sloped portion 904 may be greater than a slope S2 of first sloped portion 902, such that an item's speed increases between first sloped portion 902 and second sloped portion 904. In a preferred embodiment, first sloped portion 902 may be inclined in a downward direction relative to a first horizontal plane 950, and slope S1 of first sloped portion 902 may be about 9.5° relative to first horizontal plane 950. Moreover, second sloped portion 904 may be inclined in a downward direction relative to a second horizontal plane 960 which is parallel to first horizontal plane 950, and slope S2 of second sloped portion 904 may be about 12° relative to second horizontal plane 960. This preferred embodiment achieved superior performance with most items tested. Nevertheless, in yet another embodiment, slope S1 of first sloped portion 902 and slope S2 of second sloped portion 904 may be varied, depending on the type of item dispensed from bulk delivery apparatus 106.

[0030] Feeder bowl 101 also may comprise a sloped member 908 fixed to dispensing paths 102, such that sloped member 908 may rotate with dispensing paths 102. Sloped member 908 may be separate from second sloped portion 904, such that a gap 910 is formed between second sloped portion 904 and sloped member 908. In an embodiment, sloped member 908 may be inclined in a downward direction relative to a third horizontal plane 970 which is parallel to second horizontal plane 960. In operation, items fall from second sloped portion 904 onto the surface of sloped member 908 and, subsequently may become airborne. A slope S3 of sloped member 908 relative to third horizontal plane 970 may be selected to reduce the amplitude of the airborne items. For example, slope S3 of sloped portion 908 may be between about 1° and about 15°, and in a preferred embodiment, slope S3 of sloped portion 908 is about 15°. Moreover, dispensing paths 102 may be inclined in a downward direction, such that a slope of dispensing paths 102 is about the same as slope S3 of sloped member 908. Although in **Fig. 9** sloped member 908 is depicted as a single portion member, sloped member may be

divided into a plurality of sloped portions having varying slopes, such as described above with respect to first sloped portion 902, second sloped portion 904, and substantially cylindrical portion 906.

[0031] Referring again to **Figs. 1** and **2**, dispensing paths 102 may be positioned around feeder bowl 101 to receive items supplied by feeder bowl 101. Moreover, dispensing paths 102 may be positioned around feeder bowl 101 in a variety of configurations. As shown in **Fig. 3**, dispensing paths 102 may be positioned around a periphery of feeder bowl 101 and may extend radially from feeder bowl 101. As shown in **Fig. 4**, dispensing paths 102' may be positioned around a periphery of feeder bowl 101 and extend in an arc-shaped pattern from feeder bowl 101 in a direction that may be opposite to a direction of rotation of feeder bowl 101. The number of dispensing paths may vary. For example, forty-eight (48) dispensing paths 102, 102' may be positioned around feeder bowl 101, as shown in **Figs. 3** and **4**. According to another embodiment of the invention, approximately one hundred (100) dispensing paths 102, 102' may be positioned around feeder bowl 101. In a further embodiment of the invention, twelve (12) dispensing paths 102, 102' may be positioned around feeder bowl 101. However, any number of dispensing paths 102, 102' may be positioned around feeder bowl 101.

[0032] Moreover, each dispensing path 102 may comprise one or more channels, each of which channels may dispense items singularly. For example, each dispensing path 102 may comprise a single channel 303, as shown in **Fig. 3**. However, each dispensing path may comprise a pair of channels, three channels, four channels, or more.

[0033] A bulk delivery apparatus 104 may be used to deliver items to rotary, vibratory dispenser. Bulk delivery apparatus 104 may be positioned adjacent to rotary, vibratory dispenser, as shown in **Fig. 1**, to deliver items to rotary, vibratory dispenser, e.g., to feeder bowl 101 of rotary, vibratory dispenser. Bulk delivery apparatus 104 may include a bulk delivery drive 104a, e.g., a vibration device, a motor, or the like, for controlling a rate of delivery of items from bulk delivery apparatus 104 to rotary, vibratory dispenser. Adjustment of bulk delivery drive 104a enables adjustment of the rate of delivery of items from bulk delivery apparatus 104.

[0034] As shown in **Fig. 1**, bulk delivery apparatus 104 may comprise a hopper 104 and bulk delivery drive 104a may comprise a hopper vibration device 104a for vibrating hopper 104, so that hopper 104 may deliver items at different rates to feeder bowl 101. Such hopper vibration devices 104a may include Syntron® Electromagnetic Vibrators, which are available

from FMC Technologies Material Handling Solutions of Homer City, Pennsylvania. Other hoppers 104 and hopper vibration devices 104a may include the Skako Comassa Feeders, which are available from Skako, Inc. of Faaborg, Denmark.

[0035] In another embodiment of the invention, bulk delivery apparatus 104 may include a conveyor or the like for delivering items to feeder bowl 101 of rotary, vibratory dispenser. In a further embodiment of the invention, the rate of delivery of items from bulk delivery apparatus 104 to rotary, vibratory dispenser may be regulated by adjusting an aperture, or the like, of bulk delivery apparatus 104.

[0036] Rotary, vibratory dispenser may include a feeder bowl rotation drive 105, a feeder bowl vibration device 106, and one or more dispensing path vibration devices 107. Feeder bowl rotation drive 105 may rotate feeder bowl 101 at different rotational speeds, which may correspond to a desired rate at which packages, e.g., containers, or the like, are to be transported to dispenser 100. For example, if rotary, vibratory dispenser includes 48 dispensing paths 102 and each dispensing path 102 includes two item-dispensing channels, and rotary, vibratory dispenser 100 must fill 480 containers per minute, feeder bowl rotation drive 105 may rotate feeder bowl 101 and dispensing paths 102 at five (5) revolutions per minute (rpm), so that rotary, vibratory dispenser may dispense items to 480 containers per minute. If each dispensing path 102 includes a single item-dispensing channel, rotation drive 105 may rotate feeder bowl 101 and dispensing paths 102 at ten (10) ten rpm, so that rotary, vibratory dispenser may dispense items to 480 containers per minute.

[0037] In one embodiment of the invention, feeder bowl rotation drive 105 may rotate dispensing paths 102 in synchronization with feeder bowl 101, e.g., at a substantially similar rotational speed as feeder bowl 101. For example, feeder bowl rotation drive 105 may rotate a frame 108, which supports feeder bowl 101 and dispensing paths 102. According to another embodiment of the present invention, feeder bowl rotation drive 105 may rotate dispensing paths 102 at a rotational speed that is greater than or less than a rotational speed at which feeder bowl rotation drive 105 rotates feeder bowl 101. For example, feeder bowl rotation drive 105 may rotate dispensing paths 102 at different relative rotational speeds, e.g., via a transmission (not shown), or the like, so that a rotational speed of dispensing paths 102 may be varied relative to a rotational speed of feeder bowl 101. In a still further embodiment of the invention, feeder bowl

rotation drive 105 may rotate dispensing paths 102 in a direction of rotation that is opposite to a direction of rotation of feeder bowl 101.

[0038] Feeder bowl vibration device 106 may vibrate feeder bowl 101 at different vibrational settings, e.g., at different vibrational magnitudes, at different vibrational frequencies, in different vibrational planes, or combinations thereof, so that feeder bowl 101 may supply items uniformly to each dispensing path 102. Feeder bowl vibration device 106 may vibrate feeder bowl 101 at vibrational magnitudes and at vibrational frequencies that are proportionate to a physical characteristic, e.g., a density, a volume, a weight, a temperature, or the like, of items to be supplied by feeder bowl 101 to dispensing paths 102. Such feeder bowl vibration devices 106 may include Syntron® Electromagnetic Vibrators, available from FMC Technologies Material Handling Solutions of Homer City, Pennsylvania.

[0039] Feeder bowl vibration device 106 may vibrate feeder bowl 101 at different vibrational magnitudes, different vibrational frequencies, or both, in a first plane, in a second plane, or in a first plane and a second plane. First plane may be generally transverse to second plane. In particular, first plane may be a substantially horizontal plane, while second plane may be a substantially vertical plane. Feeder bowl vibration device 106 may vibrate feeder bowl 101 at vibrational settings that correspond to one or more of a rate of delivery of items to feeder bowl 101, a rotational speed of feeder bowl 101, or a desired rate of supplying items from feeder bowl 101 to dispensing paths 102. Feeder bowl vibrational settings may be adjusted, as necessary, so that feeder bowl 101 may receive a plurality of items, e.g., from a bulk delivery apparatus 104 or the like, and supply items uniformly to each dispensing path 102.

[0040] A dispensing path vibration device 107 may vibrate each dispensing path 102 and associated item-dispensing channel. Each dispensing path vibration device 107 may vibrate each dispensing path 102 at different vibrational settings, e.g., at different vibrational frequencies, at different vibrational magnitudes, in different vibrational planes, or combinations thereof, so that each dispensing path 102 may dispense items singularly. Moreover, each dispensing path vibration device 107 may vibrate each dispensing path 102 at different vibrational settings in a first plane, in a second plane, or in a first plane and a second plane, so that each dispensing path 102 may dispense items singularly. First plane may be generally transverse to second plane. In particular, first plane may be substantially horizontal, while second plane may be substantially vertical. Such dispensing path vibration devices 107 may include Syntron® Solid Mount Linear

Drives, which are available from FMC Technologies Material Handling Solutions of Homer City, Pennsylvania.

[0041] Each dispensing path vibration device 107 may vibrate one or more respective dispensing paths 102 proportionately to a physical characteristic e.g., a density, a volume, a weight, a temperature, or the like, of each item to be dispensed. Moreover, each dispensing path vibration device 107 may vibrate each dispensing path 102 proportionately to one or more of a rate of supply of items from feeder bowl 101 to each dispensing path 102, a rotational speed of dispensing paths 102, or a desired dispensing rate of items from each dispensing path 102.

[0042] A sensing unit may be positioned at each dispensing path 102, e.g., adjacent to a distal end of each dispensing path 102 and its associated item-dispensing channel(s). If a dispensing path 102 comprises more than one item-dispensing channel, a sensing unit may be positioned at each channel, e.g., at a distal end of each channel of a dispensing path 102. In one embodiment of the invention, a sensing unit 109 may be positioned at a dispensing head 110. For example, a sensing unit 109 may be positioned adjacent to an opening of each dispensing head 110, as shown in **Figs. 1** and **2**.

[0043] Sensing units 109 may measure a physical characteristic, e.g., a volume, a weight, a density, or the like, of each item dispensed from a dispensing path 102 or item-dispensing channel. Each sensing unit 109 transmits each measurement to a control unit, which determines whether the measurement is within a predetermined range of physical characteristics for a particular item. For example, each sensing unit 109 may comprise an optic sensor that may measure a volume of each item dispensed from a dispensing path 102 or item-dispensing channel and transmit each measurement to control unit. Control unit may compare each measurement to a predetermined range of volumes for that particular item to determine whether the measured volume of each item is within the predetermined range of volumes, or whether the measured volume for an item is greater than or less than the predetermined range of volumes for the item.

[0044] By measuring a physical characteristic of each dispensed item and transmitting each measurement to a control unit, sensing units 109 enable identification of items, the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics for the item. In this way, sensing units 109 may identify out-of-specification items, i.e., items the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics.

[0045] In addition to determining whether a measured physical characteristic of each item is within a predetermined range of physical characteristics, control unit may count items dispensed from each dispensing path 102 or channel. For example, control unit may count each item, the measured physical characteristic of which is within a predetermined range of physical characteristics. Control unit may identify each item, the measured physical characteristic of which is greater than or less than the predetermined range of physical characteristics, so that each item, the measured physical characteristic of which is greater than or less than a predetermined range, may not be counted.

[0046] Based on this measured count, control unit may activate each dispensing head 110 to direct predetermined quantities of items, the measured physical characteristic of each of which items is within a predetermined range of physical characteristics, to a container. Control unit may activate each dispensing head 110 to divert items, the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics, away from a container. Moreover, control unit may activate each dispensing head 110 to divert quantities of items in which at least one item has a measured physical characteristic that is greater than or less than a predetermined range of physical characteristics away from containers. In this way, control unit enables containers to be filled with predetermined quantities of items, the measured physical characteristic of each of which is within a predetermined range of physical characteristics. Control unit ensures that dispensing heads 110 may divert away from containers each item the measured physical characteristic of which is greater than or less than a predetermined range of physical characteristics.

[0047] As shown in **Figs. 1** and **2**, a dispensing head 110 may be positioned at each dispensing path 102 and associated item-dispensing channel to receive items dispensed from each dispensing path 102 and channel. For example, a dispensing head 110 may be positioned adjacent to each dispensing path 102, e.g., adjacent to a distal end of each dispensing path 102 and associated item-dispensing channel(s). In embodiments of the invention in which each dispensing path 102 may include more than one item-dispensing channel, a dispensing head 110 may be positioned adjacent to each channel, e.g., at a distal end of each channel of a dispensing path 102.

[0048] As shown in **Figs. 1**, **2**, and **5**, each dispensing head 110 may include an opening 111 for receiving items dispensed from each dispensing path 102 or channel, a bifurcation device

112, a first chamber 113, a second chamber 114, and a holding chamber 115. Control unit may activate bifurcation device 112 to directs dispensed items received in dispensing head 110 to first chamber 113 or second chamber 114.

[0049] **Fig. 5** shows a dispensing head 110 in which bifurcation device 112 is positioned to direct items to second chamber 514. Bifurcation device 112 may be positioned to direct items to first chamber 113. Moreover, bifurcation device 112 may remain in this position until a predetermined quantity of items is received in first chamber 113. Bifurcation device 112 then may be repositioned to direct items to second chamber 114 and to allow items in first chamber 113 to flow toward holding chamber 115. After a predetermined quantity of items is received in second chamber 114, bifurcation device 112 may be repositioned to direct items to first chamber 113 and to allow items in second chamber 114 to flow toward holding chamber 115.

[0050] Holding chamber 115 may be positioned at a lower portion of each dispensing head 110 to receive items from first chamber 113 or second chamber 114. In one embodiment of the present invention, holding chamber 115 may include a pair of doors 116, 117. Each door 116, 117 of holding chamber 115 may be activated to direct items from dispensing head 110 in a first direction, which may be toward a container or a container chute 119. Each door 116, 117 may be activated to divert items in a second direction, which may be away from a container and toward a diversion chute 120.

[0051] To direct items in a first direction, each door 116, 117 may rotate in a clockwise direction, e.g., about a pivot 119 shown in **Fig. 5**; however, one door 116 may rotate through a greater angle of displacement than the other door 117, so that an aperture forms between distal ends of doors 116, 117. Items retained by holding chamber 115 may flow along an inner surface of door 117 and through the aperture in a first direction. To direct items in a second direction, each door 116, 117 may rotate in a counter-clockwise direction, e.g., about a pivot 119, shown in **Fig. 5**; however, one door 117 may rotate through a greater angle of displacement than the other door 116, so that an aperture forms between distal ends of doors 116, 117. Items retained by doors 116, 117 of holding chamber 115 may flow along an inner surface of the other door 116 and through the aperture in a second direction. Each door 116, 117 may have a substantially planar surface or a curved surface to direct or divert items.

[0052] In an another embodiment of the present invention, holding chamber 115 may include two pairs of reconfigurable doors (not shown). One pair of doors may be positioned

beneath first chamber, while a second pair of reconfigurable doors may be positioned beneath second chamber. The first pair of reconfigurable doors may receive items from first chamber 113, while the second pair of reconfigurable doors may receive items from second chamber 114. Each pair of doors may be activated to direct items in a first direction, e.g., toward a container, or to divert items in a second direction, e.g., away from a container.

[0053] Referring to **Figs. 7a-7h**, in a modification of the embodiment of the present invention depicted in **Fig. 5**, holding chamber 115 may be replaced by a first holding chamber 115′ and a second holding chamber 115″, door 117 may be replaced by a first door 117′, and door 116 may be replaced by a guide wall 116′ and a second door 116″. First holding chamber 115′ may be positioned below second holding chamber 115″, and when second door 116″ is in a closed position, holding chambers 115′ and 115″ may form a continuous chamber. Nevertheless, when second door 116″ is in an open position, second door 116″ may prevent the items from reaching first holding chamber 116′. Specifically, bifurcation device 112 may receive the items which pass through opening 111, such that the items are positioned within first chamber 113 or second chamber 114. When bifurcation device 112 receives a predetermined number of items which have acceptable physical characteristics, e.g., physical characteristics which are within a predetermined range of physical characteristics, bifurcation device 112 may direct the received items into first holding chamber 115′ via second holding chamber 115″. First door 117′ then may move from a closed positioned to an open position, such that the items received by first holding chamber 115′ are directed toward the container. Nevertheless, if bifurcation device 112 receives any item which does not have acceptable characteristics, e.g., physical characteristics which are greater than or less than the predetermined range of physical characteristics, second door 116″ may move from the closed position to the open position, and bifurcation device 112 subsequently may direct the received items into second holding chamber 115″. When bifurcation device 112 directs the received items into second holding chamber 115″, bifurcation device 112 may receive new items, such that the new items may be positioned within first chamber 113 or second chamber 114. Moreover, when the received items reach second holding chamber 115″, second door 116″ may direct the received items away from the container. Consequently, when bifurcation device 112 receives an unacceptable item, each of the items received by the bifurcation device 112 may be directed away from the container without having to wait for bifurcation device 112 to receive the predetermined number of items.

Moreover, the new items may be received by bifurcation device 112 without having to wait for second door 116'' to direct the received items away from the container.

[0054] Referring to **Figs. 10a** and **10b**, in another modification of the embodiment of the present invention depicted in **Fig. 5**, bifurcation device 112 may be replaced by a first directional gate 112a and a second directional gate 112b, and holding chamber 115 may be replaced by a first holding chamber 115a and a second holding chamber 115b. In this embodiment, door 117 may be replaced by an accept door 117a, door 116 may be replaced by a recirculate door 116a, and dispensing head 110 may comprise means for releasing items from second holding chamber 115b. For example, the means for releasing may comprise a roller 1010 connected to recirculate door 116a. Moreover, dispensing system 100 may comprise means for separating items, e.g., a first strainer (not shown) and/or a second strainer (not shown). Specifically, the first strainer may be operationally positioned between bulk delivery apparatus 104 and dispensing head 110, such that the first strainer may prevent items having a diameter which is greater than a first predetermined diameter from entering dispensing head 110. The second strainer may be operationally positioned between second holding chamber 115b and bulk delivery apparatus 104, such that the second strainer prevents items which are released from second holding chamber 115b and have a diameter which is less than a second predetermined diameter from reentering dispensing head 110.

[0055] In operation, first directional gate 112a may receive the items which pass through the first strainer and opening 111, such that the items are positioned within first chamber 113 or second chamber 114. When first directional gate 112a receives a predetermined number of items which passed through at least the first strainer and have acceptable physical characteristics, e.g., physical characteristics which are within a predetermined range of physical characteristics, second directional gate 112b is positioned in a first position and first directional gate 112a may direct the received items into first holding chamber 115a. The container then may move to a position which is substantially, vertically aligned with first holding chamber 115a, and accept door 117a then may move from a closed positioned to an open position, such that the items received by first holding chamber 115a are directed toward bulk delivery apparatus 104 and into the container. When first directional gate 112a directs the received items into first holding chamber 115a, first directional gate 112a may receive new items, such that the new items may be positioned within first chamber 113 or second chamber 114.

[0056] Nevertheless, if first directional gate 112a receives any item which does not have acceptable characteristics, e.g., physical characteristics which are greater than or less than the predetermined range of physical characteristics, second directional gate 112b may move from the first position to a second position, and first directional gate 112a subsequently may direct the received items into second holding chamber 115b. When first directional gate 112a directs the received items into second holding chamber 115b, first directional gate 112a may receive new items, such that the new items may be positioned within first chamber 113 or second chamber 114. Moreover, dispensing head 110 may orbit around bulk delivery apparatus 104, and the means for releasing may further comprise means for altering an angle of roller 1010, such that when the angle of roller 1010 is altered, recirculate door 116a opens. For example, the means for altering the angle of roller 1010 may comprise a raised portion (not shown). When roller 1010 contacts the raised portion, roller 1010 may move in an upward direction, and recirculate door 116a automatically opens, such that the items in second holding chamber 115b are directed away from bulk delivery apparatus 104 and onto a conveyer (not shown). The second strainer then separates the items on the conveyer having a diameter less than the second predetermined diameter from the items on the conveyer having a diameter greater than or equal to the second predetermined diameter. Moreover, the items on the conveyer having a diameter greater than or equal to the second predetermined diameter are delivered to bulk delivery apparatus 104. Consequently, when a batch of items is unacceptable because one of the items in the batch does not have acceptable characteristics, those items in the batch which have acceptable characteristics may be redelivered to dispensing head 110 via bulk delivery apparatus 104, such that the number of acceptable items which dispensing system 100 disposes of may be reduced. Moreover, because the items which are not dispensed into containers are directed away from bulk delivery apparatus 104, these items may not adversely affect the components of dispensing system 100. For example, the food items may not contact or adhere to the components of dispensing system 100. Further, because the items which are not dispensed into containers are directed away from bulk delivery apparatus 104, the need to clean dispensing system 100 may occur less frequently, and dispensing system 100 more easily may be cleaned.

[0057] A dispensing and diversion system of the present invention may include a star wheel 118. As shown in **Fig. 6**, star wheel 118 may include a plurality of container-receiving grooves 601 and a plurality of apertures 602. Each container-receiving groove 601 is adapted to

receive a container C, so that star wheel 118 may transport a plurality of containers in synchronization with rotary, vibratory dispenser, e.g., at a substantially similar rotational speed as dispensing heads 110 of rotary, vibratory dispenser, in alignment with a respective dispensing head 110 of rotary, vibratory dispenser, or the like. Container-receiving grooves 601 may be positioned along a periphery of star wheel 118. Each container-receiving groove 601 is adapted to position a container in alignment with a respective dispensing path or dispensing head to receive a predetermined quantity of items. Moreover, container-receiving grooves 601 of varying dimension and shape may be mounted interchangeably to star wheel 118, so that star wheel 118 may receive and position containers of varying size and shape at different positions relative to dispensing paths 102 and dispensing heads 110.

[0058] Star wheel 118 may be driven directly by feeder bowl rotation drive 105. For example, feeder bowl rotation drive 105 may drive a frame 108 which supports star wheel 118 and feeder bowl 101. In an alternate embodiment, star wheel 118 may be driven indirectly by feeder bowl rotation drive 105, e.g., via a transmission. In a further embodiment, a separate drive may drive star wheel 118 at different rotational speeds, so that star wheel 118 may position containers in synchronization with rotary, vibratory dispenser.

[0059] A plurality of apertures 602 may be formed through star wheel 118. Each aperture 602 may extend from a top surface of star wheel 118 to a bottom surface of star wheel 118, so that items may pass through star wheel 118, via apertures 602. The number, shape, and position of star wheel apertures 602 may vary according to the number of dispensing heads 110 of rotary, vibratory dispenser, a physical characteristic of each dispensed item, a configuration of one or more chutes positioned in alignment with apertures 602, or the like.

[0060] A guard rail 603 may be positioned adjacent to star wheel 118. For example, a guard rail 603 may be positioned adjacent to a periphery of star wheel 118, as shown in **Fig. 6**. Guard rail 603 may be positioned in relation to star wheel 118, so that guard rail 603 retains each of a plurality of containers in engagement with a respective container-receiving groove 601. Moreover, guard rails 603 of varying dimension and shape may be positioned interchangeably around star wheel 118, depending upon the dimension and shape of containers to be received by star wheel 118.

[0061] As shown in **Fig. 1**, one or more container chutes 119 may be positioned on star wheel 118. Container chutes 119 may be positioned on star wheel 118 in alignment with a

respective dispensing path 102 or dispensing head 110 or both, so that container chutes 119 may receive predetermined quantities of items directed from respective dispensing heads 110. Container chutes 119 may be positioned around a periphery of star wheel 118. Each container chute 119 may be configured to direct items to a container C positioned at a respective container-receiving groove 601, as each container is transported by star wheel 118 in synchronization with dispenser.

[0062] The number, shape, and position of container chutes 119 may vary depending upon the number and configuration of dispensing heads 110 of rotary, vibratory dispenser, the number and configuration of container-receiving grooves of star wheel 118, or the like. Moreover, container chutes 119 of varying size and dimension may be positioned interchangeably on star wheel 118 to direct items of varying physical characteristics, e.g., volume, weight, density, or the like, to containers positioned around star wheel 118. In another embodiment of the invention (not shown), container chutes 119 may be positioned adjacent to star wheel 118 to receive items from dispensing paths 102 or dispensing heads 110 and to deliver the items to a respective container. For example, container chutes 119 may be supported by a respective dispensing head 110 or a frame 108, or the like, rather than being positioned on star wheel 118.

[0063] One or more diversion chutes 120 may be positioned on star wheel 118. Diversion chutes 120 may be positioned around a periphery of star wheel 118, e.g., adjacent to container chutes 119, to receive items diverted by one or more dispensing heads 110. Moreover, each diversion chute 120 may communicate with an aperture 602 of star wheel 118, so that each diversion chute 120 may divert items through a respective star wheel aperture 602 and away from containers positioned at container-receiving grooves 601 of star wheel 118. Star wheel 118 may position each diversion chute 120 in alignment with one or more dispensing heads 110.

[0064] The number, shape, and position of diversion chutes 120 may vary depending upon the number and configuration of dispensing heads 110 of rotary, vibratory dispenser, the number and configuration of star wheel apertures 602, or the like. Each diversion chute 120 may communicate with, i.e., divert items through, one or more star wheel apertures 602. Moreover, diversion chutes 120 of varying size and dimension may be positioned interchangeably on star wheel 118 to divert items of varying physical characteristics, e.g., volume, weight, density, or the like, away from containers positioned around star wheel 118. For example, diversion chutes 120

may be formed by concentric walls extending from a surface of star wheel 118 to form an annular space over star wheel apertures 602. In another embodiment of the invention, diversion chutes 120 may be positioned adjacent to star wheel 118 to receive items diverted by respective dispensing heads 110. For example, diversion chutes 120 may be supported by a frame or by a respective dispensing head 110, rather than being supported by star wheel 118.

[0065] The dispensing and diversion system of the present invention may include a rejection system. The rejection system may include a rejection conveyor 121, as shown in **Fig. 1**, and a rejection bin. The rejection conveyor 121 may be positioned beneath star wheel 118 to receive items diverted by diversion chutes 120 through star wheel apertures 602. Rejection conveyor 121 may include one or more conveying components that receive items diverted by diversion chutes. Rejection conveyor 121 may transport diverted items to a rejection bin, where diverted items may be collected. Suitable rejection conveyors 121 include conveyors powered by one or more drives to transport diverted items to a rejection bin and static conveyors, such as chutes, that receive items diverted through star wheel and guide items to a rejection bin.

[0066] According to another embodiment of the invention, each dispensing head 110 may divert items through star wheel apertures 602a to a plurality of buckets (not shown) that may be positioned beneath star wheel 118 to rotate with star wheel 118 and to receive items diverted through star wheel apertures 602. For example, a bucket may be positioned beneath one or more star wheel apertures 602 to receive items diverted through each aperture 602. Moreover, each bucket may include a cam follower that engages a cam track as each bucket rotates with star wheel 118. The cam track may be positioned adjacent to star wheel 118 and may comprise at least one cam. Engagement of the cam follower of each bucket and the at least one cam of the cam track causes each bucket to discharge the diverted items from each bucket to a rejection system, e.g., to a rejection conveyor, to a rejection chute, or the like. For example, each bucket may be mounted pivotally beneath star wheel 118, such that engagement of the cam follower of each bucket and the at least one cam of the cam track may pivot each bucket to discharge diverted items contained within each bucket to a rejection system. Moreover, the at least one cam may comprise a plurality of cams positioned along the cam track, so that each of the buckets may discharge diverted items at a plurality of locations.

[0067] The rejection system may transport the diverted items discharged by each bucket to a rejection bin, where the items may be collected. The rejection system may comprise a conveyor, a chute, or the like to transport diverted items to the rejection bin.

[0068] In operation, rotary, vibratory dispenser receives a plurality of items delivered by bulk delivery apparatus 104 to feeder bowl 101. Feeder bowl rotation drive 105 and feeder bowl vibration device 106 respectively rotate and vibrate feeder bowl 101, so that feeder bowl 101 supplies items uniformly to each of a plurality of dispensing paths 102 positioned around feeder bowl 101. Dispensing path vibration devices 107 vibrate each dispensing path 102 and associated item-dispensing channel(s), so that each dispensing path 102 and channel(s) may dispense items singularly.

[0069] Sensing units 109 measure a physical characteristic of each item dispensed from each dispensing path 102 or channel and transmit each measurement to a control unit. Control unit determines whether the measured physical characteristic of each item is within a predetermined range of physical characteristics for that item, or whether the measured physical characteristic of an item is greater than or less than the predetermined range of physical characteristics. Control unit counts each dispensed item to provide an exact count of items dispensed from each dispensing path 102 and channel. In one embodiment of the invention, control unit counts only items, the measured physical characteristic of which is within a predetermined range of physical characteristics.

[0070] A dispensing head 110 receives items dispensed from each respective dispensing path 102 and channel. Bifurcation device 112 directs items to one of a first chamber 113 or a second chamber 114 of dispensing head 110. Control unit activates bifurcation device 112 once a predetermined quantity of items is received within a respective chamber of dispensing head 110, so that the items may exit the chamber and flow to holding chambers 115. If any of the items in a predetermined quantity of items has a measured physical characteristic of which that is greater than or less than a predetermined range, control unit activates the holding chamber 115 of the respective dispensing head 110 to divert the items away from a container and toward a diversion chute 120, so that the items may pass through diversion chute 120 and star wheel 118 to a rejection conveyor. Rejection conveyor transports the items to a rejection bin. If each of the items in the predetermined quantity of items has a measured physical characteristic that is within a predetermined range of physical characteristics, control unit activates holding chamber 115 of

dispensing head 110 to direct the predetermined quantity of items to a container chute 119, so that items may pass through container chute 119 to a container positioned at a container-receiving groove 601 of star wheel 118.

[0071] Control unit may activate bifurcation device 112 to release items in a chamber as soon as an item with a measured physical characteristic that is greater than or less than a predetermined range is received in dispensing head 110. In another embodiment of the invention, control unit may increment a count of a predetermined quantity of items for each item the measured physical characteristic of which is greater than or less than a predetermined range, so that dispensing head 110 may direct a predetermined quantity of items, the measured physical characteristic of which of which is within a predetermined range of physical characteristics, to a container.

[0072] Referring to **Fig. 8**, a dispensing system 100′ according to another embodiment of the present invention is depicted. The features and advantages of dispensing system 100′ are substantially similar to the features and advantages of dispensing system 100. Therefore, the similar features and advantages of dispensing system 100 and dispensing system 100′ are not discussed further with respect to dispensing system 100′. Dispensing system 100′ may comprise feeder bowl 101, dispensing paths 102 positioned around feeder bowl 101, a dispensing path rotation drive 105′ for rotating dispensing paths 102, feeder bowl vibration device 106, and the one or more dispensing path vibration devices 107 for vibrating each dispensing path 102. In this embodiment of the present invention, feeder bowl vibration device 106 may vibrate feeder bowl 101, the one or more dispensing path vibration devices 107 may vibrate dispensing paths 102, and dispensing path rotation drive 105′ may rotate dispensing paths 102 around feeder bowl 101. For example, an edge of dispensing paths 102 may be positioned below and may overlap a portion of feeder bowl 101, such that at least one vertical plane includes both dispensing paths 102 and feeder bowl 101. Moreover, in this embodiment of the present invention, feeder bowl 101 does not rotate. Consequently, a lighter motor may be used, there are fewer moving parts is dispensing system 100′, and dispensing system 100′ may have increased control.

[0073] While the invention has been described in connection with preferred embodiments, it will be understood by those of ordinary skill in the art that other variations and modifications of the preferred embodiments described above may be made without departing from the scope of the invention. Moreover, other embodiments of the present invention will be

apparent to those of ordinary skill in the art from a consideration of the specification or a practice of the invention disclosed herein, or both.